Predictors of Expressive Vocabulary Growth in Children With Autism

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Purpose: The purpose of this exploratory study was to examine the variability and predictors of expressive vocabulary development in children with autism and very delayed language.
Method: This study involved 35 children with autism whose initial chronological ages were between 20 and 71 months and whose initial expressive vocabularies were less than 60 words. Their expressive vocabularies were measured at baseline and at 6, 12, and 24 months following the start of intervention using the MacArthur–Bates Communicative Developmental Inventory (L. Fenson et al., 1993).
Results: A cluster analysis revealed 4 distinct patterns of expressive vocabulary development over 2 years. The number of words said, the presence of verbal imitation skills and pretend play skills with objects, and the number of gestures to initiate joint attention at baseline were all associated with the cluster of children who demonstrated the most rapid expressive vocabulary growth over time. The 2 clusters of children who demonstrated the least vocabulary growth had the most significant developmental delays and autism severity at 6 months, but not at baseline.
Conclusions: This study confirms the heterogeneity in language development in young children with autism and, consistent with other reports, confirms that specific prelinguistic skills are predictive of development.

KEY WORDS: autism, language development, prelinguistic skills, cluster analysis

The course of language and communication development in individuals with autism varies greatly. The results of early studies suggest that up to 50% of individuals with autism fail to develop functional language (DeMyer et al., 1972; Rutter & Lockyer, 1967), while a more recent report suggests that approximately 25% have language skills within the normal range (Kjelgaard & Tager-Flusberg, 2001). Based on information from longitudinal studies, language delay is often parents' primary concern when children are referred for possible autism (Lord, Risi, & Pickles, 2004).

While the long-term outcomes for children with autism have improved considerably as a result of early intervention programs, professionals are still unable to provide parents with accurate prognoses based on their child's initial skill profile. On the one hand, it appears that functional language development by age 5 and more advanced language development in general are both associated with better long-term outcomes (Howlin, Goode, Hutton, & Rutter, 2004; Lord, Risi, & Pickles, 2004; Szatmari, Bryson, Boyle, & Duku, 2003). However, researchers know relatively little about outcome predictors in children with autism who are either nonverbal or demonstrate very delayed language at the time of diagnosis. Researchers' ability to understand the sources of heterogeneity in language development of children with autism has been hampered by the fact that much of the early work in this area involved

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small, cross-sectional samples, with data collected at only one or two time points. Few studies have involved longitudinal data sets that allow examination of language development over time. Such examinations are important because even children with very delayed language can show significant developmental advances as they grow older (Howlin et al., 2004). Information about the factors associated with language development over time is especially important to guide treatment decisions and set treatment priorities for the subgroup of children with the most significant delays.

Predictors of Language Development in Young Children With Autism

Although there is considerable variability in the typical rate of lexical development (Fenson et al., 1994), the average child acquires 900 root words by 2 years of age (Carey, 1978). While general intellectual functioning has been associated with vocabulary development in typical children (Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991), this finding is difficult to interpret in practical terms, especially for children with limited language abilities. The problem is compounded by the fact that most standardized tests of language require children to sit at a table, respond to verbal instructions, follow directional points, and either name or point to pictures—responses that are rarely present in the behavioral repertoires of young children with autism. In 1996, Prizant noted the importance of understanding language development in children with autism beyond the relation with general intelligence. Since then, several observational studies have explored the predictive value of prelinguistic behaviors and other early language skills, some of which are not typically included in standardized test protocols. Two sets of prelinguistic skills—verbal imitation and the ability to use early gestures that signal joint attention—have emerged as predictors of language development in these studies.

Imitation. Imitation is a skill that is present in newborns (Meltzoff & Moore, 1983) and that continues to develop in the first 2 years of life (Hanna & Meltzoff, 1993; Kuczynski, Zahn-Waxler, & Radke-Yarrow, 1987). The ability to imitate new words and actions appears to be a strategy used by infants to acquire and master new behaviors, both linguistic and motoric (Masur & Eichorst, 2002; Tomasello, Kruger, & Ratner, 1993); however, the exact nature of this relation is not clear. According to Meltzoff and Moore (2002), early motor imitation plays an important role in development and can be seen as a "primitive means of understanding and communicating with people" (p. 39). Typically developing infants show a reliable developmental sequence in the emergence of motor imitation (Hanna & Meltzoff, 1993) but vary widely with regard to vocal and verbal imitation abilities (Bloom, Lightbrown, & Hood, 1975). Nonetheless, it appears that those who exhibit more early spontaneous verbal imitation skills have larger concurrent vocabularies, as assessed by both maternal reports (Bates, Bretherton, & Snyder, 1988) and observational measures (Snow, 1989). There is also evidence that early rates of verbal imitation predict later expressive vocabulary skills in typical children (Bates et al., 1988; Masur & Eichorst, 2002).

In children with autism, imitation impairments have attracted considerable research attention (e.g., Gopnick & Meltzoff, 1993; Rogers & Pennington, 1991). Most of the early studies in this area examined the development of motor imitation in young children with autism. Although these studies concluded that the vast majority of these children have significant motor imitation deficiencies compared with mental age controls (see I. M. Smith & Bryson, 1994), more recent research has provided evidence that this is not a universal impairment (Beadle-Brown & Whiten, 2004; Rogers, Hepburn, Stackhouse, & Wehner, 2003). In addition, motor imitation skills appear to improve over time (Heimann & Ullstadius, 1999), especially in children with more advanced language abilities (Charman & Baron-Cohen, 1994; Roux et al., 1995). Stone, Ousley, and Littleford (1997) found that the ability to imitate oral and facial movements in particular predicted expressive language development in children with autism and that the extent to which this ability was impaired was associated with later language development.

Fewer studies have addressed the relation between verbal imitation and later language development in children with autism. An early study examining grammatical development and imitation found that four verbal children with high-functioning autism used a higher proportion of verbal imitations than typically developing children or those with Down's syndrome (Tager-Flusberg & Calkins, 1990). However, a reanalysis of these data, in combination with other samples of language from the Child Language Data Exchange System database, found that verbal imitation characteristics in children with autism cannot be described so simplistically (Parisse, 1999). In this reanalysis, children with autism did not imitate more single-word utterances than other children; the differences were only apparent in multiword utterances. Receveur et al. (2005) found that verbal imitation did not discriminate between children with autism with low and high IQs until the children were older than 4 years; gestural and facial imitation skills were more discriminatory for younger children. In contrast, Charman, Drew, Baird, and Baird (2003) found that problems with early word imitation coincided with expressive vocabulary delays in young children.

Joint attention. Another skill that has been associated with language development in children with autism is joint attention. Joint attention behaviors include those that allow children to share, follow, and direct the attentional focus of communicative partners (Tomasello, 1995). One such behavior is *responding to joint attention (RJA),* which involves following an adult's line of regard (e.g., a protodeclarative pointing gesture; see Leekman, Lopez, & Moore, 2000). Children can also establish coordinated attention by *initiating joint attention (IJA),* using gestures to point, show, and give (Bono & Sigman, 2004). In typically developing children, joint attention emerges in early infancy, develops over the first 18 months of life, and is considered a prerequisite for language development (Tomasello, 1992).

Young children with autism appear to demonstrate a unique impairment in the development of joint attention (Leekman et al., 2000; Mundy, 1995; Osterling & Dawson, 1994). Compared with children with other developmental disabilities, they initiate fewer bids for joint attention (IJA; Mundy, Sigman, Ungerer, & Sherman, 1986; Sigman & Ungerer, 1984). Several studies have reported associations between IJA skills and language development, such that more frequent IJA skills are associated with better early receptive and expressive abilities (Mundy et al., 1986; Sigman & Ungerer, 1984) as well as with later abilities in these areas (Sigman & Ruskin, 1999; Siller & Sigman, 2002).

There is also some evidence that other child characteristics are predictive of language development in children with autism over time. These include chronological age at the onset of intervention (Bibby, Eikeseth, Martin, Mudford, & Reeves, 2002; Fenske, Zalenski, Krantz, & McClannahan, 1985), developmental status as measured by IQ (e.g., Bibby et al., 2002; Eikeseth, Smith, Jahr, & Eldevik, 2002; Lovaas, 1987;), and autism severity (Ozonoff & Cathcart, 1998; Venter, Lord, & Schopler, 1992). In addition, Charman et al. (2003) found that word comprehension was delayed relative to word production in a large sample of preschoolers with autism, although vocabulary comprehension was not examined as a predictor of development over time.

Measuring Vocabulary Development

One issue encountered in the clinical assessment of young children with autism is that, when both language comprehension and production are very delayed, formal tests of language development may be inappropriate for measuring change over time (Mirenda, Smith, Fawcett, & Johnston, 2003). This stems from both the inflexible performance requirements inherent in such tests (as noted previously) and the fact that test tasks become increasingly more difficult as children get older (Charman et al., 2003; Lord, Risi, & Pickles, 2004). As a result, children may be unable to demonstrate the language skills they have acquired (Fenson et al., 1994). As an alternative, parent-completed vocabulary checklists have proven to be both valid and cost-effective for assessing vocabulary size and development over time in both typically and atypically developing samples of young children (Dale, Price, Bishop, & Plomin, 2003). Measures of vocabulary are also useful for examining individual differences independent of developmental level, both within and across populations.

The parent report scale of early language development that is supported with the most comprehensive standardization data and has therefore been used most often for research purposes is the *MacArthur–Bates Communicative Development Inventory* (*MCDI*; Fenson et al., 1993, 1994). Two complementary scales exist: the MCDI–Words and Gestures (WG) and the MCDI–Words and Sentences (WS). According to Feldman et al. (2005), research on the validity of the MCDI has been generally encouraging. Studies of concurrent and predictive validity between MCDI scores and both language samples and structured tests have demonstrated validity of this tool for typical populations (Dale, 1991; Fenson et al., 1994, Feldman et al., 2005). Limited validity testing of this instrument has occurred for children with developmental disabilities (for an exception, see Miller & Sedey, 1995), and further validity studies are clearly warranted. In this regard, V. Smith and Mirenda (2007) recently evaluated the concurrent and predictive validity of the MCDI–WG using a sample of 40 children with autism with initial mental ages between 6 and 18 months. Concurrent validity was examined by comparing MCDI data to the normative data published in the MCDI manual and to the children's scores on standardized measures of vocabulary. Significant correlations between .50 and .62 were obtained. Predictive validity was examined for children with mental ages below 6 months, between 6 and 12 months, and from 12 to 18 months across three time points (initially and both 12 and 24 months later). Significant correlations that ranged from .47 to .72 were obtained between the MCDI and several standardized language measures for all but very young children (i.e., those younger than 6 months). These results provide preliminary evidence for the validity of the MCDI as a measure of vocabulary development in children with autism with mental ages over 6 months.

Several investigations related to the variability of language outcomes in children with autism have examined the relations between the children's initial abilities and later language acquisition, using group comparisons at two time points. For example, Sigman and Ruskin (1999) found that language skills at age 4 predicted language development at age 10–13 in a group of 51 individuals with autism. In a more recent study, Charman et al. (2003) used data from a single administration of the MCDI–WG to parents of children with autism and found that, although the children as a whole demonstrated severe language delays, there was considerable variability in the size of their vocabularies. They also found that the children's actions on objects were relatively advanced compared with their ability to imitate and to initiate joint attention gestures. The Charman et al. study is important because it was one of the first to document both vocabulary variability and the prelinguistic skills that appear to be associated with language development in young children with autism.

The purpose of this exploratory study was twofold: (a) to extend the work of Charman et al. (2003) by examining the variability in expressive vocabulary development in children with autism with very delayed language, over multiple administrations of the MCDI, and (b) to examine the predictive value of chronological age, developmental level, autism severity, and specific early language skills reported by parents at baseline using the MCDI. We hypothesized that young children with autism whose parents reported better initiation of gestures for joint attention and verbal imitation skills at baseline would demonstrate relatively higher rates of expressive vocabulary development over time. We were also interested in exploring how early prelinguistic behaviors from the MCDI (i.e., pretend object use and early and late gesture production), early word and phrase comprehension, and number of words said at baseline were associated with vocabulary development over time.

Method

Participants

Participants were 35 children with autism (28 boys and 7 girls), with a mean chronological age of 45;59 (*SD* = 9.89; range = 20.50–67.60 months) and a mean mental age of 18;34 (*SD* = 7.35; range = 6.00–36.00 months). They were selected from a larger sample of 70 children who participated in a study of the outcomes of early intervention in British Columbia, Canada (Mirenda, Bopp, Smith, Kavanagh, & Zaidman-Zait, 2005). The criterion for inclusion in the present study was a baseline expressive vocabulary of less than 60 words, as measured by the MCDI–WG. All children were diagnosed by multidisciplinary diagnostic teams not associated with the study as having autistic disorder according to the criteria of the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; American Psychiatric Association, 1994). In addition, as part of the baseline evaluation, the children met the criterion for autism according to the Childhood Autism Rating Scale (Schopler, Reichler, & Rochen-Renner, 1988). The majority of the children in the present sample came from middle-income households, and the mean household occupation score was 3.66 out of a possible 9 (Hollingshead, 1975), indicating "skilled manual worker." All but two children were from two-parent homes at the start of the study. Sixty-five percent were Caucasian, 25% were Asian, and 10% were from other ethnic groups. English was spoken in the homes of all 35 children, with a second language spoken in 25% of the households and three families having a primary language other than English (i.e., Vietnamese, Tagalog, and Japanese). In general, the children received an average of 15–20 hr/week of intervention that consisted of (a) structured teaching based on the principles of applied behavior analysis, (b) speech-language therapy, (c) occupational therapy, or (d) preschool services, individualized for each child.

Procedure

Children were assessed 4 times in their home communities over 2 years (i.e., prior to initiating intervention and 6, 12, and 24 months thereafter). There was an average of 6 months (*SD* = 0.74) between the first, second, and third evaluations and an average of 12 months (*SD* = 2.04) between the third and fourth evaluations. Assessments of developmental status, autism severity, and early language development were completed at baseline and repeated at each subsequent evaluation. In addition, parents completed either the MCDI–WG or the MCDI–WS at each evaluation point.

Developmental status. Intellectual testing in very young children is often achieved with the use of developmental scales (Klin, Saulnier, Tsatsanis, & Volkmar, 2005). Such scales provide an estimate of cognitive functioning rather than IQ in acknowledgment of the close interdependence between cognitive functioning with other domains of development (Klin et al., 2005). In this study, developmental status was assessed at baseline and 6 months later using the *Mullen Scales of Early Learning* (*MSEL*; Mullen, 1995), a multidomain standardized assessment measure that can be used with children between 3 and 70 months of age. The MSEL yields both mental age equivalence scores and an Early Learning Composite (ELC) score. Typically developing children achieve an ELC of 100 (±15), which is derived from their performance on four domains of development: visual reception, receptive language, expressive language, and fine motor skills. In the study sample, baseline ELC standard scores ranged from 48.00 to 63.00, with a mean of 48.91 (*SD* = 2.95).

Autism severity. The *Childhood Autism Rating Scale* (*CARS*; Schopler et al., 1988) was used at each time point to determine autism severity. The CARS is an observational rating scale administered by a psychologist who rates 15 behaviors associated with autism on a scale of 1 (*no evidence of impairment*) to 4 (*severe impairment*). The total CARS scale score of 30 or above is associated with autism. In the study sample, baseline CARS scores ranged from 30.00 to 50.50, with a mean of 38.86 (*SD* = 4.69).

Prelinguistic and early language development. Data on the children's prelinguistic and early language development were obtained from primary caregivers (in most cases, the mother) using the MCDI–WG, the MCDI–WS, or both In Part 1 of the MCDI–WG, the parent is asked whether the child (a) responds to simple spoken words (e.g., to his or her name; to "No!"); (b) understands each of 28 simple phrases (e.g., "Do you want more?"); and (c) imitates words or phrases (e.g., says "work now" after mother says, "Mommy's going to work now"). This section also includes a 396-item vocabulary list organized into 19 semantic categories, on which the parent indicates which words the child understands and which words the child produces. Part 2 of the MCDI–WG focuses on the child's production of both early and later gestures. Within the early gestures category, the first 3 items represent initiations for joint attention (i.e., extends arm to show you something he or she is holding, reaches out and gives you a toy or some object that he or she is holding, and points with arm and index finger extended at some interesting object or event). The final 9 items include conventional gestures such as waving bye-bye and shaking the head "no." Within the later gestures category are four subgroups: (a) games and routines (e.g., plays peek-a-boo), (b) actions with objects (e.g., eats with a spoon and a fork), (c) pretending to be a parent (e.g., feeds an animal/baby with a bottle), and (d) imitating adult actions (e.g., puts a key in a door or lock). The MCDI–WS also consists of two parts. Part 1 is a 697-item vocabulary checklist grouped into 21 semantic categories on which the parent is asked to indicate which words the child produces. Part 2 addresses aspects of syntax and sentence development that are beyond the scope of this study.

At baseline, the caregivers of all 35 children completed the MCDI–WG. In subsequent evaluations, caregivers completed the MCDI–WG if the child produced 50 words or less and the MCDI–WS if the child produced more than 50 words. This was done to avoid ceiling effects on the MCDI–WG and to achieve a more comprehensive picture of the children's vocabulary growth over time.

Data Analysis

We used Ward's Method of cluster analysis (Ward, 1963) to identify subgroups of children who demonstrated distinctly different patterns of vocabulary development over the 2-year period. Cluster analysis is an exploratory technique (Hartigan, 1975) and is used to classify data into "meaningful piles." It was used for this analysis instead of mixed level modeling because there was an insufficient sample size to satisfy the normal curve assumption necessary for growth curve analysis (Singer & Willett, 2003). Growth curve estimators (i.e., slopes) of "words produced" as reported on the MCDI at the four time points were used as the criterion variable to group children into clusters in a manner that optimized the minimum variance within clusters (Aldenderfer & Blashfield, 1984). This analysis enabled us to identify patterns of vocabulary growth over time within groups that were relatively similar, as well as patterns between groups that were different (Burchinal & Appelbaum, 1991). The final clusters were identified by examining the value of the coefficients and inspecting the graphical clustering of the data (i.e., dendrograms). The cluster categories were coded 1, 2, 3, or 4.

Following identification of the clusters, we conducted a series of general linear model analyses of variance (ANOVAs) or general linear model analyses of covariance (ANCOVAs) to determine whether specific child characteristics at baseline differentiated the clusters. ANOVAs were used when chronological age was not considered a potential confound. ANCOVAs with chronological age at baseline entered as a covariate were used in other analyses, based on research demonstrating that age is a potential confound when considering predictors of expressive vocabulary development, in particular (Fenson et al., 1994; Huttenlocher et al., 1991). In these analyses, both total CARS scores and total ELC scores at baseline and 6 months were examined as predictors. In addition, from the MCDI–WG, we examined baseline scores for (a) the presence or absence of both verbal imitation and pretend object use (each coded as 1 = present and 0 = not present); (b) the number of phrases understood, from a list of 28; (c) the number of vocabulary words understood and produced, from a list of 396; (d) the number of conventional gestures produced, from a list of 9; (e) the number of gestures to initiate joint attention produced, from a list of 3; (f) the number of gestures produced for games and routines, from a list of 6; (g) the number of actions with objects produced, from a list of 17; (h) the number of gestures produced for pretending to be a parent, from a list of 13; and (i) the number of imitations of adult actions, from a list of 15.

To provide information about the magnitude of difference beyond statistical significance and in light of the small sample size, we also calculated eta-squared effect sizes for each of our analyses. According to Cohen (1988), effect sizes ranging from .059 to .137 are considered moderate, and those greater than .137 are considered large. When significant differences were found among the clusters on child characteristics measured at baseline, Scheffé post hoc tests were also conducted (the Scheffé test was selected over the Tukey test due to unequal group sizes).

Results

Cluster Analysis

Examination of the value of the coefficients and graphical representation of the possible clusters (i.e., the dendrograms) identified that a four-cluster solution was most probable. Table 1 provides information regarding the characteristics of participants in the four clusters.

Table 1. Baseline CA, CARS scores, and ELC scores at baseline and 6 months for participants in four clusters.

Cluster	CA (in months) baseline	CARS baseline	CARS 6 months	ELC baseline	ELC 6 months
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
1	46.08 (10.53)	39.34 (4.13)	41.18 (4.27)	48.43 (1.75)	48.00 (0)
2	46.41 (8.40)	30.57 (4.04)	39.73 (4.11)	48.00 (0)	48.00 (0)
3	47.07 (6.71)	38.00 (6.46)	36.43 (5.73)	50.71 (5.61)	51.00 (5.86)
4	40.76 (14.34)	36.10 (4.34)	31.80[a] (9.31)	49.20 (2.68)	56.20[a] (13.46)

Note. CA = chronological age; CARS = Childhood Autism Rating Scale; ELC = Early Learning Composite from the Mullen Scales of Early Learning.

[a]Significantly different from Cluster 1, *p* < .05.

Cluster 1 (see Figure 1) included 15 participants (42.9%) and was characterized by flat growth with only a slight incline. These children's expressive vocabularies increased a mean of 9.74 words over 24 months. Total expressive vocabulary after 2 years of intervention ranged from 0 to 56 words.

Cluster 2 (see Figure 2) included 8 participants (22.9%) and was characterized by a slow incline that was especially noticeable between the 12- and 24-month assessments. These children's vocabularies increased an average of 200.25 words over 24 months, with more than half of the increase ($M = 135.35$ words, representing 65% of the total) occurring during the second year. Total expressive vocabulary after 2 years of intervention ranged from 139 to 314 words.

Cluster 3 (see Figure 3) included 7 participants (20%) who produced few words at baseline but displayed a high, steady increase in vocabulary development. These children's expressive vocabularies increased a mean of 453.43 words over 24 months. Total expressive vocabulary after 2 years of intervention ranged from 399 to 620 words.

Finally, Cluster 4 (see Figure 4) included 5 participants (14. 2%) and was characterized by a very steep rate of vocabulary growth that was more dramatic than that seen in Cluster 3. These children's vocabularies increased a mean of 638 words over 24 months. Total expressive vocabulary after 2 years of intervention ranged from 646 to 697 words.

Predictors of Expressive Vocabulary Growth

ANOVAs were conducted to determine whether the four clusters differed at baseline with regard to chronological age, total CARS scores, or ELC. No significant differences were found for any of these variables at baseline: $F(3, 31) = 0.46$, $p = .71$; $F(3, 31) = 1.03$, $p = .39$; and $F(3, 31) = 1.27$, $p = .30$, respectively. A subsequent set of ANOVAs was also conducted for total CARS scores

Figure 1. Cluster 1 (*n* = 15): Flat growth in vocabulary production.

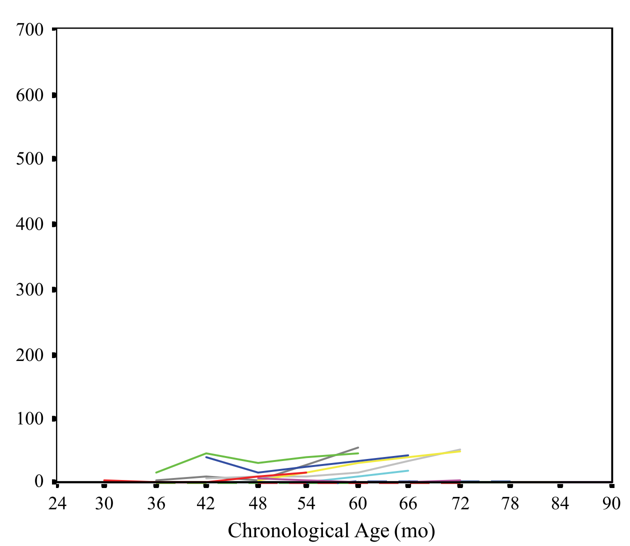


Figure 2. Cluster 2 (*n* = 8): Slow incline in vocabulary production.

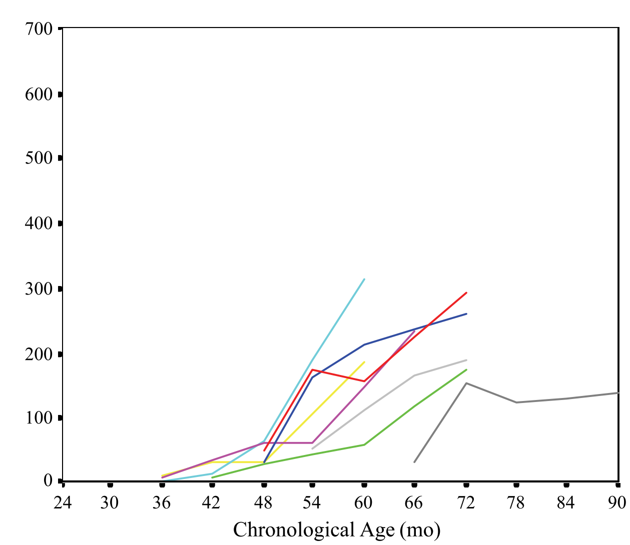


Figure 3. Cluster 3 ($n = 7$): High, steady increase in vocabulary production.

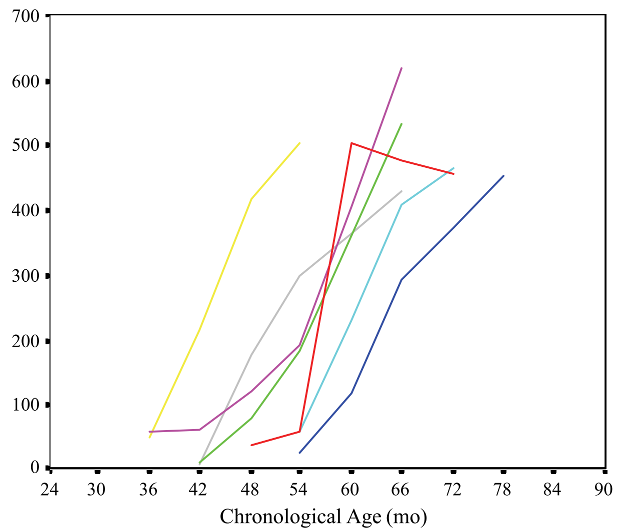
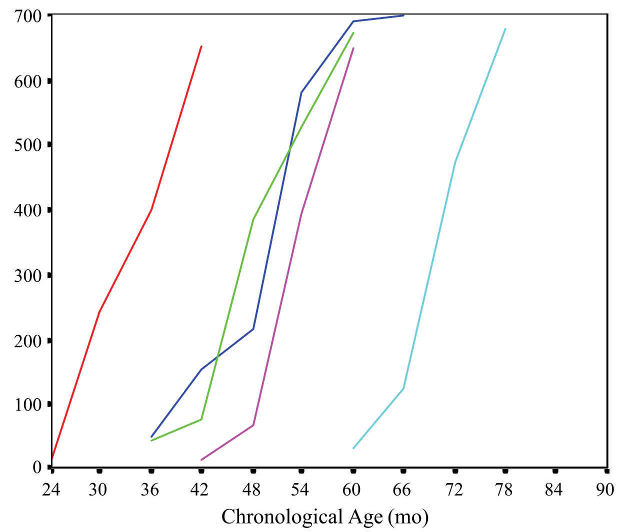


Figure 4. Cluster 4 ($n = 5$): Steep rate of growth in vocabulary production.



and ELC scores at 6 months. The results were significant for both the CARS at 6 months, $F(3, 31) = 3.63$, $p = .02$, partial $\eta^2 = .26$, and for ELC at 6 months, $F(3, 31) = 3.21$, $p = .04$, partial $\eta^2 = .24$. Scheffé post hoc tests revealed a significant difference between Clusters 1 and 4 ($p = .04$) for both CARS and ELC at 6 months.

A number of specific child characteristics at baseline were also examined in a series of ANCOVAs, with chronological age at baseline as the covariate. Table 2 displays the mean number of phrases understood, words comprehended, and words produced at baseline by participants in each cluster.

No significant differences between clusters were found with regard to either phrases understood or words comprehended at baseline: $F(4, 30) = 1.50$, $p = .24$ and $F(4, 30) = 1.61$, $p = .21$, respectively. However, the number of words produced at baseline was significantly different by cluster, $F(4, 30) = 6.42$, $p < .002$, partial $\eta^2 = .39$. Post hoc pairwise comparisons among the adjusted means revealed significant differences between both Clusters 1 and 3 ($p = .01$) and Clusters 1 and 4 ($p = .002$).

Table 3 displays the percentage of children in each cluster whose parents reported that they demonstrated verbal imitation and use of gestures to pretend at baseline. Table 3 also displays the mean number of joint attention and early symbolic gestures at baseline for each cluster.

Differences between the clusters were found for three of the four sets of prelinguistic behaviors that were examined. Verbal imitation was significantly different at baseline by cluster, $F(4, 30) = 3.62$, $p = .02$, partial $\eta^2 = .27$. Post hoc pairwise comparisons of the adjusted means revealed that Cluster 1 had significantly lower verbal imitation scores at baseline, compared with Cluster 2 ($p = .01$), Cluster 3 ($p = .001$), and Cluster 4 ($p = .05$). Using objects to pretend was also significantly different by cluster at baseline, $F(4, 28) = 5.72$, $p = .003$, partial $\eta^2 = .38$. Post hoc pairwise comparisons of the adjusted means revealed that Cluster 1 had significantly lower scores in this behavior at baseline, compared with both Cluster 2 ($p = .02$) and Cluster 4 ($p = .02$).

No significant differences were found between the clusters for symbolic gestures, $F(4, 30) = 1.26$, $p = .31$. However, there were significant differences for IJA gestures, $F(4, 30) = 3.39$, $p = .03$. Post hoc pairwise comparisons among the adjusted means revealed significant differences between both Cluster 1 and Cluster 4 ($p = .02$) and Cluster 2 and Cluster 4 ($p = .02$).

Table 4 displays the mean number of four types of later gestures from the MCDI–WG, as reported at baseline for participants in each cluster.

Across all four clusters, only one quarter or fewer of the actions for "pretending to be a parent" were evident in the study sample. On the other hand, one half or more of adult actions on the MCDI–WG were imitated by children regardless of cluster. However, no significant differences were found for any of the later gesture categories as predictors of language development over 2 years: games/routines, $F(4, 30) = 1.42$, $p = .25$; actions with objects, $F(4, 30) = 1.42$, $p = .26$; pretending to be a parent, $F(4, 30) = 1.02$, $p = .40$; and imitating adult actions, $F(4, 30) = 0.82$, $p = .50$.

Discussion

Using parent report data from the MCDI, we examined the development of expressive vocabulary over a 2-year period in a sample of 35 young children with

Table 2. MCDI–WG phrases understood, words comprehended, and words produced at baseline by participants in four clusters.

	Phrases understood (out of 28)		Words understood (out of 396)		Words produced (out of 396)	
Cluster	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range
1	13.93 (9.04)	0–28	129.56 (114.45)	6–393	7.19 (12.42)	0–40
2	11.85 (5.08)	4–21	75.28 (44.18)	13–116	23.14 (21.44)	0–53
3	15.28 (4.39)	7–28	144.71 (53.34)	70–216	35.71[a] (21.95)	6–60
4	19.00 (6.63)	16–28	178.20 (97.98)	78–326	31.20[a] (16.69)	14–51

Note. MCDI = MacArthur–Bates Communicative Development Inventory; WG = Words and Gestures.

[a]Significantly different from Cluster 1 ($p < .05$).

autism, all of whom had expressive vocabularies of 60 words or less at baseline. The results suggested four distinct patterns of vocabulary development. Large differences among clusters were seen with regard to the number of words produced at baseline; 47% of the children in Cluster 1 (the group with the slowest rate of vocabulary development) produced no spoken words at baseline, while no such children were present in either Cluster 3 or Cluster 4 (the two groups with the most rapid vocabulary growth). Comparisons among the four clusters replicated the findings of both cross-sectional studies (Sigman & Ruskin, 1999) and experimental studies (Dawson et al., 2004) in which multiple predictors appeared to contribute to the development of language skills in young children with autism. In the present analysis, the number of words produced at baseline, the presence of verbal imitation skills and use of objects to pretend, and the number of gestures to initiate joint attention were all found to be associated with greater vocabulary growth over time and distinguished the four clusters. Neither cognitive status as estimated by the MSEL nor autism severity (as measured by total CARS scores) was predictive of vocabulary development until 6 months following the initiation of intervention.

Research indicates that children with autism represent a heterogeneous group, especially with regard to language development (Lord, Risi, & Pickles, 2004). The results reflect this heterogeneity in that four distinct growth trends for expressive vocabulary were evident. The rates of vocabulary development for all four clusters were well below that expected for typically developing children, even in Cluster 4, whose vocabulary increased to an average of 638 words (as measured by the MCDI–WS) over 2 years. Both within and across the four clusters, the number of words produced and words understood varied widely (see Table 2), congruent with the patterns observed in other MCDI studies with both typically developing children (Fenson et al., 1993) and those with autism (Charman et al., 2003).

Interestingly, chronological age at baseline (i.e., just prior to the initiation of intervention) was not predictive of the children's rates of vocabulary growth. For example, one of the children in Cluster 4 (the group whose vocabulary growth was most rapid over 2 years) was 60 months of age at baseline while another child in the same cluster was only 20 months of age. The lack of association between chronological age at the start of intervention and language development over time contradicts previous work indicating such an association (Bibby et al., 2002; Fenske et al., 1985). Additionally, it is significant that the ELC score, an estimate of cognitive status, was not a discriminative characteristic for language development until

Table 3. MCDI–WG baseline scores for verbal imitation, use of objects to pretend, gestures to initiate joint attention, and symbolic gestures by participants in four clusters.

	Verbal imitation	Use of objects to pretend	Gestures to initiate joint attention		Conventional gestures	
Cluster	Children demonstrating (%)	Children demonstrating (%)	*M* (*SD*)	Total (%)	*M* (*SD*)	Total (%)
1	25[a]	0[b]	1.31 (1.14)	47	2.81 (2.20)	32
2	75	50	1.14 (1.06)	44	3.85 (0.90)	56
3	43	17	2.14 (0.90)	71	4.14 (1.95)	57
4	80	60	2.60[c] (0.55)	87	4.20 (0.84)	47

[a]Significantly different from Clusters 2, 3, and 4 ($p < .05$). [b]Significantly different from Clusters 2 and 4 ($p < .05$). [c]Significantly different from Clusters 1 and 2 ($p < .05$).

Table 4. MCDI–WG baseline scores for gestures related to games and routines, actions with objects, pretending to be a parent, and imitating adult actions for participants in four clusters.

Cluster	Games/routines		Actions with objects		Pretending to be a parent		Imitating adult actions	
	M (*SD*)	Total (%)	*M* (*SD*)	Total	*M* (*SD*)	Total (%)	*M* (*SD*)	Total (%)
1	2.12 (1.36)	37	7.69 (3.60)	47	2.75 (3.32)	20	7.88 (3.32)	49
2	2.71 (1.70)	48	10.57 (2.88)	63	2.57 (3.55)	21	8.00 (3.05)	56
3	3.86 (0.90)	64	9.43 (2.64)	55	0.86 (0.90)	7	7.57 (2.88)	51
4	3.40 (0.55)	57	8.00 (3.16)	47	3.40 (2.61)	26	8.20 (2.39)	55

6 months after the initiation of intervention. This finding is concordant with data reported by Lord and Schopler (1989), who found that early assessments of intelligence were not predictive of language development in children with language ages of less than 23 months.

We hypothesized and subsequently found significant relations between vocabulary development and both verbal imitation skills and joint attention gestures, with large effect sizes. This finding is consistent with the results of several recent studies of similarly aged children with autism in which joint attention and imitation skills were both associated with greater gains in language (Bono & Sigman, 2004; Dawson et al., 2004; Siller & Sigman, 2002; Stone & Yoder, 2001). However, our findings with regard to joint attention must be interpreted with caution. We were able to measure only IJA using three items from the MCDI–WG; RJA was not measured. Previous studies have found a stronger relation between RJA and later language development than IJA and later language development. For example, Sigman and Ruskin (1999) found that (a) language ability in children with autism at age 4 was concurrently correlated with both IJA and RJA, (b) higher scores in IJA and RJA at age 4 predicted expressive language at age 5, and (c) only RJA at age 4 predicted language development at ages 10–13. Thus, although the relation that we found between IJA and expressive language was significant 2 years later, it may not be predictive of later language development.

We also found that none of four types of later gestures were predictive of language development. Interestingly, few of the actions that involved pretending to be a parent were evident in the repertoires of even the children in Clusters 3 and 4, who made the most vocabulary progress over time. This is congruent with previous reports of the absence of pretend play skills in children with autism in general (e.g., Sigman & Ruskin, 1999).

Limitations

We acknowledge a number of limitations to the present study. First, the sample size ($N = 35$) was small, although it was comparable to other longitudinal studies that have examined development in young children with autism. For example, previous studies have examined word loss or regression in 68 children with autism (Lord, Shulman, & DiLavore, 2004); improvements in cognition and language from preschool to adolescence in 48 individuals (McGovern & Sigman, 2005); the stability of IQ scores in 33 children (Lord & Schopler, 1989); the contributions of maternal responsivity and joint attention in 25 children (Siller & Sigman, 2002); and changes in cognitive and adaptive behavior in 18 children with autism (Frisch, Simensen, & Schroer, 2002). In addition, because of the small sample size, our analysis was confined to an exploratory analysis in which the data were sorted into four categorical clusters. This may have resulted in a loss of information in the individual child trajectories of vocabulary growth over time.

Another limitation pertains to the measurement error that is potentially associated with repeated used of the parent report instrument. Previous examinations of this issue have been inconclusive regarding the influence of parent characteristics (i.e., age, gender, and social class) acting systematically on the variables measured on the MCDI. Initial normative data produced for the MCDI reported large individual differences in the child skills measured with this instrument and provided data indicating that these differences were unrelated to parental age, gender, or social class (Fenson et al., 1994). In subsequent reports, concerns were raised about the accuracy of reports by parents with low socioeconomic status, in particular. One study reported that parents with low socioeconomic status tended to underestimate their children's vocabulary (Roberts, Burchinal, & Durham, 1999), whereas another reported overestimation (Pan, Rowe, Spier, & Tamis-LeMonda, 2004). Reports by Feldman et al. (2000, 2005) suggested that parents who complete the MCDI–WS are reasonably good informants about their children's expressive language skills; however, less information is available for the MCDI–WG. With regard to the present study, it is unlikely that socioeconomic status contributed to systematic measurement error because the majority of participants were from middle-income families.

Another potential source of systematic measurement error stems from the fact that some of the parents completed different versions of the MCDI (i.e., WG and WS) after Time 1. Specifically, all parents in Cluster 1 (i.e., the cluster with the slowest vocabulary growth) completed the MCDI–WG after Time 1, whereas 50% of the parents in Cluster 2 and 100% of the parents in Clusters 3 and 4 completed the MCDI–WS. In a study that examined the validity and reliability of the two versions of the MCDI, the authors reported substantial continuity and stability between both repeated measures of the MCDI–WG and between the MCDI–WG and the MCDI–WS across a 6-month period (Fenson et al., 1994). These findings provide some support for repeated use across forms of the MCDI, although they do not preclude the possibility of correlated measurement error.

A second potential problem with use of two forms of the MCDI is that the WG version has a total of 396 vocabulary items and the WS version has a total of 697. By using the WG version with children whose vocabularies were under 60 words, we may have inadvertently restricted the vocabulary options available to these children's parents at each time point. An alternative would have been to use only the 396 vocabulary items that were common to both forms of the instrument, across the four time points. However, we were primarily interested in examining the extent and variability of vocabulary growth over time. Limiting the number of vocabulary items by using only the 396 common items would likely have resulted in an underestimation of the number of vocabulary words produced by the more verbal children in the sample. On the other hand, it seemed unreasonable to ask the parents of children with little or no speech to complete the WS form with 697 words. It is clear that additional research is needed to examine how specific characteristics of parents of children with autism might influence the results of studies that rely on parent reports and how to best measure changes in language and other skills with this population over time (Lord, Shulman, et al., 2004; Rutter, 2005).

Summary

In this study, we extended the results of previous group analyses (e.g., McGovern & Sigman, 2005) to an individual differences model of development by employing a measure of within-individual change over four time periods. We also extended the work of Charman et al. (2003) by using MCDI data collected over several time points, which allowed us to examine vocabulary development over 2 years and variables that predicted the rate of growth. Of course, data derived from measures other than the MCDI may achieve greater specificity in predicting outcomes for children with autism and very delayed language skills (Lord, Risi, et al., 2004). However, the MCDI appears to be a simple, valid, and cost-effective method of assessing early linguistic behavior in atypical populations, as evidenced by the congruence between our results and those of Charman. Future research is needed to compare these results with those derived from other measures and to examine additional prelinguistic predictors that might be amenable to intervention.

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